

- b) Distribution control and management station.
  - c) Network interconnecting infrastructure.
- SAN Unit
  - 2: The method of claim 1, item a) further contains IP SAN services software modules, which is able to provide SAN services to distribution control and management station and client hosts through TCP/UDP/IP or other protocols.
  - 3: The method of claim 1, item a) further identified that a Fibre Channel Based SAN unit can appear as an IP based SAN, as long as a Fibre Channel to IP gateway used to translate the protocol between Fibre Channel and IP.
- The Distributed Control and Management Station.
  - 4: The method of claim 1, wherein,
    - Item (b) further comprises distributed control and management software modules, which provides control, management, and distribution for entire virtual SAN operation through TCP/UDP/IP or other protocols such as virtual SAN auto-configuration, disk/raid configuration, disk/raid partitioning, security management, SAN storage volume allocation or de-allocation to client hosts and data sharing by client hosts, fault handling management, data replication and backup/restore management, etc..
    - Item (b) further comprises a IP SAN unit list, with which each entry on the list contains information of an individual IP SAN unit such as unit name, unit IP address, and storage media such as disk/Raid and storage volumes/partition information etc.
- The Network Interconnecting Infrastructure
  - 5: The method of claim 1, wherein,
    - Item c) further comprises switches, routers and gateways, which either network cable connected (Fibre optical or cat5, or other cable) or wireless connected.
    - Item c) also further identified that in order for the distributed virtual SAN, be operated not only in the LAN environment but also in a cross network domain environment, the network software infrastructure such as DNS is required.
- The Method of Virtual SAN Automatic Configuration in a Cross Network Domain Environment
  - 6: The Virtual SAN can be automatically configured and built in a cross network domain environment based on:
    - a) "Virtual SAN automatic configuration protocol"
    - b) The DNS infrastructure in the network infrastructure.
  - 7: The methods of claim 6, wherein,
    - Item a) further comprises the protocol sequence, which has defined and described in this invention and pictured in Fig. 3.

- 8: The method of claim 6, wherein,
  - Item a) further requires the "Virtual SAN automatic configuration protocol" be executed at IP SAN unit system startup (boot up) time if the IP SAN unit was powered off, or at network bring up time if the IP SAN unit's network link was down.
  - Item a) further requires the "Virtual SAN automatic configuration protocol" be executed at IP SAN unit shutdown time.
- 9: The method of claim 6, wherein,
  - Item a) further clarify that "Virtual SAN automatic configuration protocol" is a UDP/IP based protocol and it also could be a other based protocol, which is compatible with UDP/IP.
- 10: The method of claim 6, wherein,
  - Item a) further clarifies that the startup packet, which sent by IP SAN unit to distribution control management station, could be a SNMP trap of cold start, a SNMP trap of link up, or a much simple UDP packet, which indicates the system startup.
- 11: The method of claim 6, wherein,
  - Item a) further clarifies that the shutdown packet, which sent by IP SAN unit to distributed control management station, could be a SNMP trap of link down or a much simple UDP packet, which indicates a system down.
- The Application of Automatic Configuration in Other Scalable distributed System
  - 12: The combined method of claim 10 and the method of claim 11,
 

Further identified that the method and principle of automatic configuring a scalable distributed virtual SAN in a cross network domain environment can also be applied for automatic configuration of all other scalable distributed system in cross network domain environment. This kind of scalable distributed system could be video server, Web server, Web cache, Web proxy server, database server, and other servers, which require and support massively parallel processing computing environment.
  - 13: The method of claim 10, and the method of claim 11,
 

Further proved that automatic configuration of distributed server system can let the distributed server become a true scalable system. That is the system's capacity of services increased at each server unit's boot time, the system's capacity of services decreased at unit shutdown time.
- The Method of Allocate, Access and Share Storage in Distributed Virtual SAN.
- 14: The Access of Distributed Virtual SAN comprises following steps:

- a) The client hosts make storage volume requests with specific size to distribution control management station.
- b) The distributed control management station examines all IP SAN units under its control and assigns appropriate volumes on one or more IP SAN units to client hosts depends on requests.
- c) Client hosts setup a direct data link to the assigned SAN units and access volumes on IP SAN unit.

15: The method of claim 14, wherein

Step b) further identified that a single IP SAN unit may be assigned to multiple client hosts if it has enough volumes configured. Therefore, an IP SAN unit can be shared and accessed by multiple client hosts in a cross network domain environment.

16: All claimed methods for distributed virtual SAN by using IP SAN can apply to other protocol based SAN as long as those protocols are compatible with TCP/UDP/IP and are perform similar functionalities for distributed virtual SAN.